U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
Division of Forest Insect Research

STUDY PLAN FOR DETERMINING THE EFFECT OF DEFOLIATION BY THE DOUGLAS-FIR TUSSOCK MOTH ON GROWTH AND MORTALITY OF WHITE FIR ON THE STANISLAUS NATIONAL FOREST, CALIFORNIA

Introduction

In 1956, 9,500 acres of white fir on the Stanislaus National Forest were aerially sprayed with DDT and diesel oil to control an infestation of Douglas-fir tussock moth, Hemerocampa pseudotsugata McD.[1/] The infestation was first reported and checked by Station entomologists in 1954. This was the first substantiated report of tussock moth on the Stanislaus National Forest though it was known to have occurred on the Inyo National Forest in 1934-1938. Subsequent checks of the Stanislaus N.F. in 1955 and 1956 indicated that defoliation was severe and that a control operation was warranted.[2/] During June and July 1956, the areas of infestation were surveyed and population levels sampled.[3/] In late July and early August, the aerial spray program was successfully completed. It was felt that further studies of the extent of damage caused by the insect would be desirable, and that these studies should include a talley of tree mortality attributed to the tussock moth and a measurement of the reduction of annual increment caused by the defoliation. To make such studies, it was decided to establish a series of permanent tagged-tree plots throughout the infestation.

Past Work

There have been several infestations of tussock moth reported in California over the past fifty years. The first record was given by J.M. Miller of the Forest Insect laboratory, who noticed dead and dying fir on the Stanislaus and Sierra National Forests in 1910. Miller thought that the fir mortality was the result of tussock moth defoliation during the years 1904-06. The moth was next reported in a small infestation near Rush Creek, Modoc N.F., by K.A. Salman in

---

1/ Control of an infestation of the Douglas-fir tussock moth with DDT Aerial spray, Calaveras and Tuolumne Counties, California - by R.E. Stevens. Berkeley, Calif. Feb. 1957.

2/ Douglas-fir Tussock Moth, Crane Meadows and Thunder Hill areas, Stanislaus N.F., Fall 1955. Appraisal survey by G.C. Trostle, Berkeley, Calif., Feb. 1956.

3/ Work plan for Station phases of Tussock Moth control, Stanislaus N.F., California. July 5, 1956 - by R.E. Stevens, Berkeley, Calif. July 1956.

1936 and the same year in the Mammoth area, Inyo N.F. by D. DeLeon. The Mammoth infestation, by far the largest, covering approximately 15,000 acres, was extensively surveyed by J.E. Patterson in 1937.[4] It consisted of 6 areas with the Hess Mill Hill the largest area, the center of defoliation, comprising 800 acres. In 1937 Patterson established a 5-acre rectangular plot on Hess Mill Hill to use in mortality and growth studies. No reports were published on the results of the study, but unpublished field notes indicate that of a total of 163 white fir on the plot, 46 percent had been killed five years later either as a direct result of tussock moth defoliation or subsequent Scolytus attacks. Growth loss from a radial increment study of 20 cores indicated that there was radial increment reduction for all defoliated trees; and that the amount of this reduction seemed to be correlated to the degree of defoliation, with the most heavily defoliated trees losing the most radial increment. Patterson also carried on life history studies in the Mammoth area and found that the infestation had probably started in 1931 and had subsided by natural causes in 1938. Unfortunately, the study was started at the end of the infestation cycle and terminated before enough records could be gathered on mortality and radial increment loss of defoliated white fir.

During the 1954 infestation, some question arose concerning the taxonomy of the tussock moth found in California. In 1956 the name was changed from Oslar's tussock moth, Hemerocampa oslari (Barnes), to Douglas-fir tussock moth, Hemerocampa pseudotsugata, after a study of the California moth by E.L. Todd of the Insect Identification and Parasite Introduction Section, Entomology Research Branch, ARS, USDA.[5] There have been much more extensive studies and control operations against the tussock moth in Region 4. But most of these studies relate to the tussock moth's principal host, Douglas-fir, and not to defoliation effects upon white fir, as found in the Sierra Nevada of California. Therefore, they are not cited in this study plan.

Location of the Study

The infested areas consist of 7 units of varying acreage strung out in a 35-mile chain on the Stanislaus N.F. They are on the west-side of the Sierra, parallel to the crest, at an average elevation of 5,000 feet (see map). These areas are generally in pure white-fir type on ridge tops and vary in size from 350-5,900 acres. Each separate area was given a unit name for the control project, and the unit names

---

4/ Tussock Moth, Hemerocampa oslari: Preliminary examination of infested areas on the Inyo and Mono National Forests, California. June 23-25, 1937. J.E. Patterson, Berkeley, Calif. July 20, 1937.

5/ The Douglas-fir tussock moth in California. Charles B. Eaton and George R. Struble. Pan Pacific Entomologist, Vol. XXXIII, No. 3-pp. 105-108. July 1957.

are retained for this study. The northernmost units had the lightest defoliation, which increased in the southern areas. The units used for study locations were Summit Level Ridge, Thunder Hill, Lily Creek, and Hells Mt., reading from north to south.

Objectives

The purpose of the study is to ascertain the effect Douglas-fir tussock moth defoliation has upon white fir. This will include both direct and indirect-caused mortality as well as growth reduction. Growth loss from repeated defoliation will be studied with a view towards the amount of reduction of radial increment and period of this reduction.

Specifically, the objectives are as follows:

Effect of defoliation on:

1. Mortality of white fir on the study plots

   a. Determine mortality directly caused by complete defoliation of the tree.

   b. Determine subsequent mortality of white fir caused by other contributing insects or agents over a period of 5 years.

   c. Determine the amount of progressive top-killing of defoliated trees.

2. Radial increment reduction of white fir on the study plots

   a. Determine radial growth reduction in white-fir stands heavily defoliated as compared with moderately, light, and non-defoliated stands.

   b. Determine the period of time that radial growth reduction is in effect on defoliated stands after an infestation.

Procedures

The main objectives of the study will be covered in 2 phases. One, the radial increment study will be carried out in 1960, and involves taking an increment boring from each living dominant and co-dominant white fir in each plot. The other phase, will include an annual check of all the plots. This inspection will record trees killed outright by the tussock moth, weakened trees subsequently killed by other causes, and any progressive top-kill of the heavily defoliated trees.

Specifically, procedures will be carried out as follows:

1. Mortality

a. To determine mortality of white fir directly caused by complete defoliation, a series of 1/2-acre tagged-tree plots with 1/40-acre subplots for small trees have been established throughout the infested units.6/ These plots will be checked annually during the summer, if possible in the middle of August, for any changes on the numbered trees. Information will be recorded on the attached form (page 9) for all trees.

b. To determine subsequent mortality of white fir, by year, the same plots and procedures will be used, and the agent causing final death will be recorded on the attached form.

c. To determine the amount of top-killing of defoliated trees, by year, the same procedures and recording form will be used.

2. Radial increment

a. To determine radial growth reduction:

(1.) An increment core will be taken on every dominant and co-dominant white fir over 6.6 inches on every plot in early September 1960. Every core will be numbered with tree number and plot number.7/

(2.) A comparable number of borings will be taken from dominant and co-dominant trees of different species. If possible, these trees will be on the plots; if not, trees nearby can be used. Cores will be numbered like nearest plot and will also have a Y or M indicating young or mature. This will be one check.

(3.) Forty borings will be taken from equal numbers of young and old, dominant and co-dominant uninfested

---

6/ 1956 Progress report on study for determining effect of defoliation by the Douglas-fir tussock moth on growth and mortality of white fir on the Stanislaus N.F., California, by Boyd E. Wickman, Berkeley, Calif. Dec. 1957.

7/ Study plan for the 1957 season, Line Project FS-2-14-15 Cal., lodgepole needle miner - biology, ecology, and control - by George R. Struble, Berkeley, Calif. May 1957.

white fir in a stand comparable to the infested area. Half of these borings will come from uninfested white fir at the northern end of the infestation and the other half from uninfested white fir at the southern end of the infestation. They will be marked N or S, designating north or south, and Y or M and D or C for dominant or co-dominant. This will be the second check.

(4.) Five young dominants will be felled on each plot and a wafer section cut at the base, mid-crown, and top. These sections can show marked differences in growth reduction in different parts of the trunk, if such differences exist. They will be marked by tree number and plot number; B for base, M for mid-crown or T for top.

(5.) Numbered trees will be remeasured for D.b.h. to nearest .1" in 1960.

b. To determine the period of time that radial growth is in effect on defoliated stands after an infestation:

(1.) The 1937 tussock moth plot at Moss Mill Hill will be re-established in 1957 by placing a reference sign and marking the corners.

(2.) An increment core will be taken from every dominant and co-dominant white fir over 6.6 inches in 1960. These cores will be marked MH-Y or M, and D or C.

Reporting

1. Progress reports will be made yearly some time after the summer checks. They will cover the mortality and top-killing phases and any other unusual circumstances. They should include several black and white photographs showing any progress or decline of certain trees.

2. A final report covering both radial increment results and mortality will be made after the 1960 check and subsequent core analysis.

3. These reports will be written by the man in charge of the field work.

Assignment of Personnel and Costs

At present the study will be under the direction of the author. Summer field assistants will aid in checking plots, taking increment

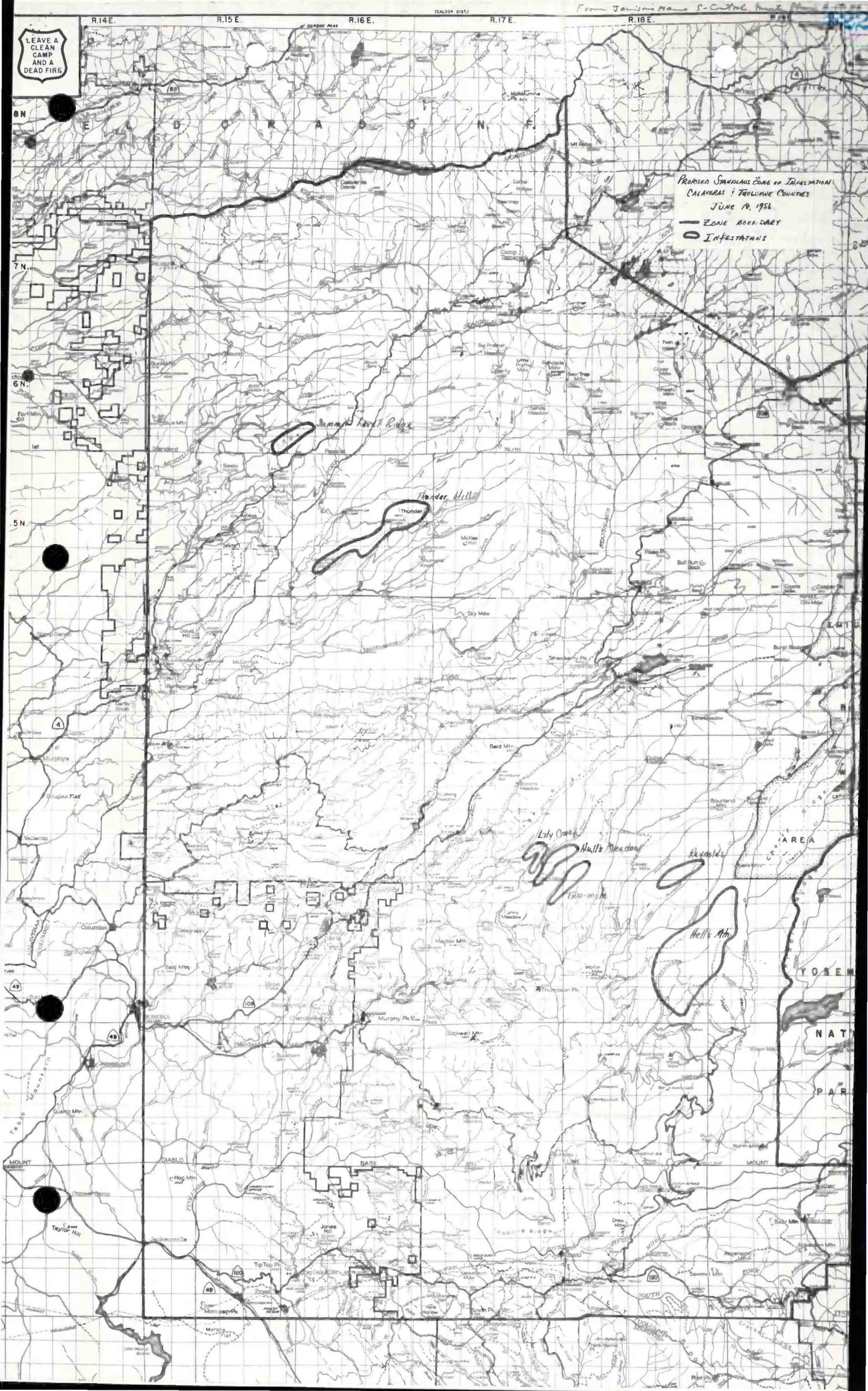
borings and analyzing cores. The cost to date of establishing the plots has been about $300 plus salaries.

Submitted by: Boyd E. Wickman

Approved by: Charles B. Calvin

Attachments
Map
Sample form

December 18, 1957
Berkeley, California


LEAVE A CLEAN CAMP AND A DEAD FIRE
R.14E.
R.15E.
R.16E.
R.17E.
R.18E.
8N
7N.
6N.
5N.
EL DORADO N. F.
PROPOSED STANISLAUS ZONE OF INFESTATION
CALAVERAS & TUOLUMNE COUNTIES
JUNE 19, 1958
ZONE BOUNDARY
INFESTATIONS
Thunder Hills
Lily Creek
Hells Meadow
Reynolds
Hells Mtn
Two-mile
Baldwin Ridge
Dry Mdw
Baldwin Mtn
Douglas Flat
Vallecito
Columbia
Jamestown
Quartz Mtn
Chinese Camp
Taylor Hill
Jacksonville
Tip Top Pk
Moccasin Pk
Murphys
Murphy Pk
Dockwell Mtn
Mt Preston
Hog Mtn
Jones
Smith Pk
Sawmill Mtn
Ascension Mtn
Thompson Pk
Maggie Mtn
Mt Provo
Buckhorn Mtn
Hobron Hill
Marina Flat
Hole Hollow
Drew Mdw
Wolfin Mdw
Wilson Mdw
Burst Rock
Strawberry Pk
Bull Run Rock
McKee Hill
Shumaker Knob
Pleasant Valley
Standard
Sweet Home
Douglas Flat
Vallecito
Columbia
Springfield
Bald Mtn
Jamestown
Quartz Mtn
Chinese Camp
Taylor Hill
Jacksonville
Tip Top Pk
Moccasin Pk
Marina Flat
Murphys
Murphy Pk
Dockwell Mtn
Mt Preston
Hog Mtn
Jones
Smith Pk
Sawmill Mtn
Ascension Mtn
Thompson Pk
Maggie Mtn
Mt Provo
Buckhorn Mtn
Hobron Hill
Hole Hollow
Drew Mdw
Wolfin Mdw
Wilson Mdw
Burst Rock
Strawberry Pk
Bull Run Rock
McKee Hill
Shumaker Knob
Pleasant Valley
Standard
Sweet Home
Douglas Flat
Vallecito
Columbia
Springfield
Bald Mtn
Jamestown
Quartz Mtn
Chinese Camp
Taylor Hill
Jacksonville
Tip Top Pk
Moccasin Pk
Marina Flat
Murphys
Murphy Pk
Dockwell Mtn
Mt Preston
Hog Mtn
Jones
Smith Pk
Sawmill Mtn
Ascension Mtn
Thompson Pk
Maggie Mtn
Mt Provo
Buckhorn Mtn
Hobron Hill
Hole Hollow
Drew Mdw
Wolfin Mdw
Wilson Mdw
Burst Rock
Strawberry Pk
Bull Run Rock
McKee Hill
Shumaker Knob
Pleasant Valley
Standard
Sweet Home

S A M P L E

TUSSOCK MOTH DEFOLIATION STUDY

Plot No. 22 Page No. 1

Defoliation Intensity Light Established by BEW, JZ, JT, JV Date 8/9/56

Tree no.	Tree species	D.b.h.	Crown class	Defol. % 1956	Percent of crown killed 1956	1957	1958	1959	1960	Tree killed by year
1	WF	19.1	CD	10	-					
2										
3										
4										
5										
--										
--										
--										

Sub Plot

1	WF	5.2	S	5						
2										
3										
4										